

What is claimed is:

1. A blood sugar level measuring apparatus comprising:

a heat amount measuring unit for measuring a plurality of temperatures derived from the body surface in order to obtain information used for calculating the amount of convective heat transfer and the amount of radiation heat transfer concerning the dissipation of heat from the body surface;

an oxygen volume measuring unit for obtaining information concerning the volume of blood oxygen;

a storage unit for storing the relationships between blood sugar levels and the individual parameters corresponding to both the multiple temperatures and blood oxygen volume;

a computing unit for converting the measurement values provided by the heat amount measuring unit and the oxygen volume measuring unit into parameters, and computing a blood sugar level by applying the parameters to the relationships stored in the storage unit; and

a display unit for displaying the blood sugar level computed by the computing unit.

2. The blood sugar level measuring apparatus according to claim 1, wherein the oxygen volume measuring unit comprises a blood flow volume measuring unit for obtaining information concerning the volume of blood flow, and an optical measuring unit for obtaining blood hemoglobin concentration and hemoglobin oxygen saturation.

3. The blood sugar level measuring apparatus according to claim 2, wherein the blood flow volume measuring unit comprises a body-surface contact unit; an indirect temperature detector for detecting the temperature at a position distanced away from the body-surface contact unit; and a heat conducting member connecting the body-surface contact unit and the indirect temperature detector.

4. The blood sugar level measuring apparatus according to claim 2, wherein the blood flow volume measuring unit comprises:

- a body-surface contact unit;

- an adjacent temperature detector disposed adjacent the body-surface contact unit;

- an indirect temperature detector for detecting the temperature at a position distanced away from the body-surface contact unit; and

- a heat conducting member connecting the body-surface contact unit and the indirect temperature detector.

5. The blood sugar level measuring apparatus according to claim 2, wherein the optical measuring unit comprises:

- a light source for generating light of at least two different wavelengths;

- an optical system for irradiating the body surface with light emitted by the light source; and

- a photodetector for detecting the light reflected by the body surface.

6. The blood sugar level measuring apparatus according to claim 5, wherein the results of detection by the photodetector are used for computing blood hemoglobin concentration and hemoglobin oxygen saturation.

7. The blood sugar level measuring apparatus according to claim 1, wherein the heat amount measuring unit comprises:

- an ambient temperature detector for measuring the ambient temperature;

- and

- a radiation temperature detector for measuring the radiation heat from the body surface.

8. A non-invasive blood sugar level measuring apparatus comprising:

- a temperature measuring unit for measuring a plurality of temperatures from a body surface;

- a blood flow volume measuring unit for obtaining information concerning the volume of blood flow based on the results of measurement by the temperature measuring unit;

- an oxygen volume measuring unit for determining the volume of blood oxygen based on the result of measurement by the blood flow volume measuring unit;

- a storage unit for storing the relationships between blood sugar levels and individual parameters corresponding to the multiple temperatures, the volume of blood oxygen and the volume of blood flow;

- a computing unit for converting the measurement values provided by the temperature measuring unit, the blood flow volume measuring unit and the oxygen volume measuring unit into parameters, and computing a blood sugar level by applying the parameters to the relationships stored in the storage unit; and

- a display unit for displaying the blood sugar level computed by the computing unit.

9. The blood sugar level measuring unit according to claim 8, wherein the blood flow volume measuring unit comprises:

- a body-surface contact unit;

- an adjacent temperature detector disposed adjacent the body-surface contact unit;

- an indirect temperature detector for detecting the temperature at a position distanced away from the body-surface contact unit; and

- a heat conducting member connecting the body-surface contact unit and the indirect temperature detector.

10. The blood sugar level measuring apparatus according to claim 8, further comprising an optical measuring unit, the oxygen volume measuring unit comprising:

- a light source for generating light of at least two different wavelengths;

- an optical system for irradiating the body surface with light emitted by the light source; and

- a photodetector for detecting the light reflected by the body surface,

wherein

- the oxygen volume measuring unit further employs the result of detection by the photodetector in determining the volume of blood oxygen.

11. The blood sugar level measuring apparatus according to claim 10, wherein the result of detection by the photodetector is used in calculating the blood hemoglobin concentration and hemoglobin oxygen saturation.

12. A blood sugar level measuring apparatus comprising:

- an ambient temperature measuring unit for measuring the ambient temperature;

- a body-surface contact unit to be brought into contact with a body surface;

- a radiation heat detector for measuring the radiation heat from the body surface;

- a heat conducting member disposed in contact with the body-surface contact unit;

- an indirect temperature detector disposed adjacent the heat conducting member and away from the body-surface contact unit for detecting the temperature at a position distanced away from the body-surface contact unit;

- a light source for irradiating the body-surface contact unit with light of at least two different wavelengths;

a photodetector for detecting reflected light produced as the light from the light source is reflected by the body surface;

a computing unit comprising a converting portion and a processing portion, wherein the converting portion converts the outputs of the indirect temperature detector, the ambient temperature measuring unit, the radiation heat detector, and the photodetector into individual parameters, and wherein the processing portion stores the relationships between the parameters and blood sugar levels in advance and computes a blood sugar level by applying the parameters to the stored relationships; and

a display unit for displaying the blood sugar level produced by the computing unit.

13. The blood sugar level measuring apparatus according to claim 12, wherein the light is used for measuring the blood hemoglobin concentration and hemoglobin oxygen saturation.

14. The blood sugar level measuring apparatus according to claim 12, further comprising:

a plate adapted to cover an opening end of the heat conducting member in contact with the body-surface contact unit; and

an adjacent temperature detector for detecting the temperature of the plate,

wherein

the output of the adjacent temperature detector is converted into a parameter by the converter unit.

15. The blood sugar level measuring apparatus according to claim 14, wherein the thermal conductivity of the plate is higher than that of the heat conducting member.

16. The blood sugar level measuring apparatus according to claim 12, further comprising:

- a first optical fiber connecting the light source and the body-surface contact unit; and

- a second optical fiber connecting the body-surface contact unit and the photodetector,

wherein

the body surface is irradiated with the light from the light source transmitted via the first optical fiber, and the reflected light is guided to the photodetector via the second optical fiber.

17. The blood sugar level measuring apparatus according to claim 12, further comprising an infrared lens disposed between the body-surface contact unit and the indirect temperature detector.

18. A blood sugar level measuring apparatus comprising:

- an ambient temperature measuring unit for measuring the ambient temperature;

- a body-surface contact unit to be brought into contact with a body surface;

- a heat conducting member disposed in contact with a first region of the body-surface contact unit;

- an indirect temperature detector disposed adjacent the heat conductive member and away from the body-surface contact unit for detecting the temperature at a position distanced away from the body-surface contact unit;

- a cylindrical member disposed in contact with a second region of the body-surface contact unit and having an opening on one end thereof;

- a radiation heat detector disposed adjacent the other end of the cylindrical member for measuring the radiation heat from the body surface;

a light source for irradiating the one end of the cylindrical member with light of at least two different wavelengths;

a photodetector for detecting reflected light produced by the reflection of the light by the body surface;

a computing unit comprising a converting portion and a processing portion, wherein the converting portion converts the outputs of the indirect temperature detector, the ambient temperature measuring unit, the radiation temperature detector, and the photodetector into individual parameters, and wherein the processing portion stores the relationships between the parameters and blood sugar levels in advance and computes a blood sugar level by applying the parameters to the relationships; and

a display unit for displaying the blood sugar level produced by the computing unit.

19. The blood sugar level measuring apparatus according to claim 18, wherein the first and the second regions are disposed adjacent to each other.

20. The blood sugar level measuring apparatus according to claim 18, further comprising:

a first optical fiber connecting the light source and the one end of the cylindrical member; and

a second optical fiber connecting the one end and the photodetector, wherein

the light emitted by the light source is guided through the first optical fiber and is then shone on the body surface, and the reflected light is guided through the second optical fiber onto the photodetector.

21. The blood sugar level measuring apparatus according to claim 18, further comprising an infrared lens disposed between the second region and the indirect

temperature detector.